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Regional Sediment Management (RSM) Strategy for Mobile Bay, Alabama

by Larry Parson, Nathan Lovelace, Elizabeth Godsey, Kevin Reine, and Joseph Gailani

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) reviews the development of a Regional Sediment Management (RSM) implementation strategy for Mobile Bay, AL. The objective of this strategy is to bring lessons learned through application of RSM and Engineering With Nature (EWN) principles and practices in the coastal environment to a broader perspective for sediment and related environmental management planning for Mobile Bay, specifically the placement within Mobile Bay of maintenance material dredged from the Mobile Harbor navigation channel. The Northern Gulf of Mexico (NGOM) RSM demonstration project concluded in 2003 (Rosati et al. 2001 [rev. 2004]). The U.S. Army Corps of Engineers (USACE), South Atlantic Division (SAD), Mobile District (SAM), continues to implement into District practice the RSM lessons learned from those NGOM studies. RSM is a systems-based approach for collaboratively addressing sediment-related issues within a regional context. RSM seeks to support sustainable solutions for more effective use of littoral, estuarine, and riverine sediment resources in an environmentally sensitive and economically efficient manner.

BACKGROUND: Mobile Bay is the terminal repository of sediments transported downstream from several riverine systems. SAM maintains the federally authorized Mobile Harbor Navigation Project (MHNP). The majority of the MHNP consists of the 45-feet-deep by 400-feet-wide Mobile Bay ship channel extending northward from the mouth of Mobile Bay for 29 miles to the mouth of the Mobile River (Figure 1). Material in the Mobile Bay channel consists of fine grain sediments, with some sand located in the upper channel reaches near the lower end of the Mobile River.

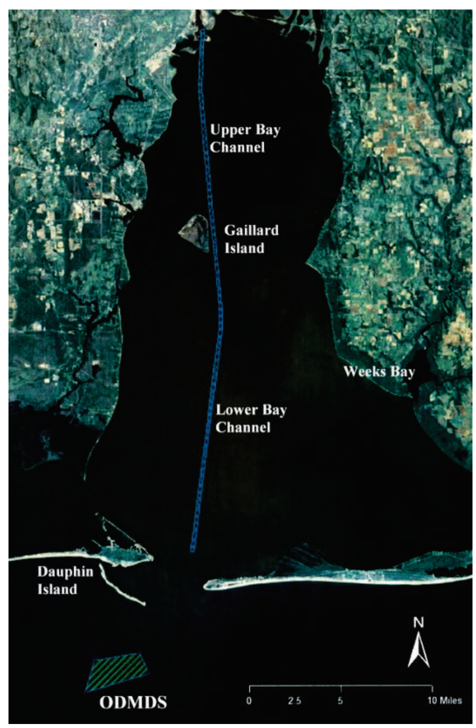

Figure 1. Mobile Bay ship channel, Weeks Bay, and Ocean Dredged Material Disposal Site (ODMDS).

From its conception in the early 1800s, the majority of material dredged from the Mobile Bay channel was placed in the adjacent waters using mechanical dredges that side casted the material alongside the channel. In the late 1800s, this practice was changed to the use of hydraulic cutterhead dredges. The majority of the side-casting and earlier adjacent open-water hydraulic placements of material resulted in dredge material mounds in the shallow water just outside and parallel to the channel limits. As positioning technology advanced and overall

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14. ABSTRACT
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environmental awareness elevated, hydraulic cutterhead dredges were able to more accurately control the material placement location and lift thickness, thus avoiding mounding, at a placement cost of approximately \$2/cubic yard (yd^3).

In November 1986, the Water Resources Development Act (WRDA 86) completely changed the dredging and material placement practices by requiring all material dredged from Mobile Bay channel to be placed in the approved Mobile North Ocean Dredged Material Disposal Site (ODMDS) located south of Dauphin Island, as much as 40 miles from the north end of Mobile Bay (USACE 2013a). This disposal practice means maintenance dredging operations will be conducted exclusively by hopper dredge equipment at a cost of approximately \$6/yd^3. Since 1986, approximately 4 million yd^3 per year (myd^3/yr) of annual maintenance material have been removed by hopper dredges from the Mobile Bay channel and placed in the ODMDS. The effect of this sediment loss can be seen in recession of wetlands and submerged aquatic vegetation (SAV) beds in the north and west portions of Mobile Bay (Byrnes et al. 2013). The present annual maintenance plan for the Mobile Bay channel hinges on rental hopper dredging of critically shoaled areas with little extra advanced maintenance that lowers channel reliability and often strains relations with the Alabama State Port Authority, harbormaster, and the deep-draft users.

Historical placement areas used within Mobile Bay prior to 1986 have been utilized during emergency operations following Hurricanes Georges (1998) and Katrina (2005). Following Hurricane Georges, the upper Mobile Bay channel (north of Gaillard Island) experienced significant shoaling that threatened safe navigation. The hopper dredging fleet was not able to keep up with the dredging demands, which resulted in the need to employ cutterhead pipeline methods to quickly restore safe navigation to the Mobile Bay channel. Subsequently, two pipeline dredging operations were conducted in both the lower Mobile Bay channel (south of Gaillard Island) and the upper Mobile Bay channel (north of Gaillard Island) (Figure 1), placing approximately 6.4 myd^3 total. Thin-layer dispersal techniques were utilized to place the material as thinly as possible but not to exceed 12 inches (in.) thickness. Similarly, the use of pipeline dredging equipment was employed for the upper Mobile Bay channel following Hurricane Katrina and also utilized open-water, thin-layer placement (TLP) of approximately 3.6 myd^3 total. These placement areas range in water depth from aproximately –6 feet (ft) to –10 ft. There are no bottom communities such as sea grasses or oyster beds known to exist within these areas.

During 2012 recertification of the MHNP, a Bay open-water TLP option using historic open-water sites was approved for emergency situations. Due to excessive shoaling in the upper Mobile Bay channel, the channel width was being compromised, and a critical need arose to restore the channel to full operational dimensions. SAM exercised the emergency option in 2012 by utilizing Mobile Bay open-water TLP since dredged material could not be hauled to the ODMDS if the channel authorized dimensions were to be maintained within budget. Data collected from monitoring the TLP of 9 myd^3 in the open-water, thin-layer disposal sites were used to model and evaluate the behavior of sediment placed within Mobile Bay.

SEDIMENT TRANSPORT WITHIN MOBILE BAY: A sediment budget for Mobile Bay was developed by leveraging efforts between the Mobile Bay National Estuary Program (MPNEP) and SAM (Byrnes et al. 2013). The Mobile Bay watershed covers two-thirds of Alabama with five rivers draining into Mobile Bay, including the (1) Mobile, (2) Tensaw, (3) Dog, (4) Deer, and (5) Fowl Rivers. As river discharge enters Mobile Bay from the north, energy decreases, and

sand falls out. South Mobile Bay is predominately fine grained and is mixed by benthic organisms and wind-wave events. Waves generated in the Gulf of Mexico that propagate into Mobile Bay have minimal impact on Mobile Bay sediments. However, wind-waves generated within Mobile Bay itself create bottom shear stresses more than adequate to initiate and sustain significant Mobile Bay sediment transport. The deep navigation channel within the shallow Mobile Bay, with an active sediment transport pattern, acts as a sink for migrating sediments that are deposited within the channel.

Historical shoreline and bathymetric surveys for the period 1917 to 2011, as well as detailed channel dredging and placement records, were the primary sources of data compiled by Byrnes et al. (2013) for evaluating sediment transport quantities and patterns within Mobile Bay to develop an operational sediment budget. Channel maintenance dredging quantities for this period exceeded sediment input from the Bay watersheds by approximately 1.6 myd^3/yr. However, shoreline recession and wetland loss could not be directly correlated to the removal of sediment from Mobile Bay.

According to Byrnes et al. (2013), net sediment movement within the Bay indicates that placement of sediment within Mobile Bay is most similar to natural long-term depositional processes. Dredged material placement that focuses on TLP farther from the margins of the channels would be beneficial to both channel dredging operations and benthic ecology. Dredged material placed farther from the channel may prevent excess maintenance dredging resulting from transport of sediment from channel margins back into the channel. Furthermore, TLP provides for faster recovery of Mobile Bay benthic communities and has a less permanent impact on benthic ecology (USACE 2013a).

STRATEGIC SEDIMENT MANAGEMENT ALTERNATIVES: The requirement to use hopper dredges for Mobile Bay dredging limits SAM's access to a smaller percentage of the available dredging fleet. Hauling material from the Mobile Bay channel to the ODMDS by hopper dredge permanently removes sediment from the natural system. Removal of sediment from Mobile Bay may not be the most environmentally sound method of disposing of the dredged sediment and may have long-term negative effects. Beneficial use (BU) activities were reauthorized by WRDA 96 which states that "for the Mobile Harbor Navigation Project, alternatives to disposal of materials in the Gulf of Mexico may be considered, including environmentally accepted alternatives for beneficial uses of dredged material." Re-establishing BU and other environmentally acceptable alternatives within Mobile Bay may contribute to much-needed conservation of various ecological resources that exist in the Mobile Bay system. BU alternatives will allow utilization of cutterhead dredge equipment with more cost-effective disposal practices by utilizing a greater percentage of the dredge fleet.

The intent of investigating potential BU alternatives is to modify the present sediment management practices and develop a placement strategy within Mobile Bay that meets the operation and maintenance (O&M) needs for Mobile Harbor that is consistent with environmental standards. All efforts involving the selection of potential BU placement alternatives are being coordinated through the Mobile Harbor Interagency Working Group (IWG). The IWG introduced in 2011 the following BU placement alternatives to be investigated as part of the MHNP: 1) filling Brookley Hole, 2) resumption of TLP within Mobile Bay, 3) creation of upper Mobile Bay emergent tidal marsh, and 4) continued placement of a portion of channel dredging in the ODMDS (USACE 2013a).

Figure 2. Upper portion, Mobile Bay, AL, showing Brookley and Airport Holes.

Brookley Hole. Brookley Hole is an estuarine dredged borrow pit from which material was removed for construction of the Brookley airfield (Figure 2). The basin and surrounding area are totally submerged with depth in the basin of approximately 23 ft and varying from 3 ft to 6 ft for the surrounding Mobile Bay bottom (USACE 2012a). Three filling scenarios for Brookley Hole were considered by the IWG: 1) One alternative was to place enough material into the pit to bring the bottom elevation up to a level where the basin would no longer exhibit hypoxic conditions (approximately 12 ft from basin bottom), thereby returning some level of environmental productivity. This, in turn, would allow for the re-establishment of benthic invertebrates in the pit basin while not adversely impacting the pit with regards to fish utilization or recreational fishing. 2) A second alternative consisted of successive dredge and fill cycles to return the bathymetry to historical depth contours matching existing surrounding bottom habitat. Filling to this level would allow the bottom, after consolidation of the dredged material, to support establishment of natural communities such as SAV and oyster beds. 3) A third alternative was to continue placement in successive dredging cycles until elevations were created that would support an emergent wetland. Such a feature would provide a variety of natural ecosystems that would be beneficial to numerous birds, fish, and benthic communities.

Pre- and postinitial placement monitoring of Brookley Hole. The consensus of the IWG was to fill Brookley Hole in stages. Postrestoration monitoring would then be used to evaluate the performance of the fill and to then decide on a final plan. Prior to restoration efforts, the U.S. Army Engineer Research and Development Center (ERDC) began a joint study under the Dredging Operations and Environmental Research Program (DOER) with SAM in 2011 to assess habitat quality of Brookley Hole (Reine et al. 2013). For purposes of comparison, a nearby borrow pit designated as Airport Hole (Figure 2) was identified as a reference site. The initial placement action consisted of pumping approximately 1.2 myd^3 of fine-grained material from the upper reach of the Mobile Bay navigation channel into the deepest area of Brookley Hole. This was accomplished in the summer of 2012 by using a 30 in. hydraulic cutterhead pipeline dredge. No material was placed in Airport Hole.

Prior to restoration, conditions were not suitable to sustain a healthy finfish assemblage in the lower water column of Brookley Hole (Reine et al. 2013). During the course of surveys undertaken during the prerestoration study, there was evidence of periodic water column stratification that induced hypoxic and/or anoxic water quality conditions. Hypoxic/anoxic conditions were most severe during summer and least severe during fall. During fall, lowest dissolved oxygen (DO) readings were slightly below 3 milligrams per liter (mg/L). During both spring and summer, DO fell to near 0 mg/L, particularly in the lower 3 ft of the water column. Hypoxic (3 mg/L) conditions were present during the spring and summer at depths greater than approximately 10 ft and during the fall at depths greater than approximately 13 ft. During

postrestoration sampling, DO concentrations did not fall below 6 mg/L during any seasonal survey (Reine and Clarke, in preparation).

Average number and variety of taxa increased significantly during postrestoration sampling. Average taxa in Airport Hole during spring sampling were similar to that of Brookley Hole. During the spring sampling in Airport Hole, there was no evidence of hypoxia. Average number of taxa was similar to results obtained from postrestoration sampling in Brookley Hole.

The results of conventional and acoustic fisheries sampling indicated that both borrow pits were seasonally occupied by fishery resource assemblages typical of greater Mobile Bay. Species composition included several taxa that exemplify coastal pelagic and demersal fishes as well as commercially important shellfish. Several pelagic forage fishes were present in each dredged hole. There was strong evidence of fish avoiding the lower depth strata in Brookley Hole during prerestoration monitoring, with fish usage increasing considerably in the postrestoration monitoring.

At Brookley Hole, Atlantic croaker was prominent in both the pre- and postrestoration collection, followed by Mobile Bay anchovy. With the absence of juvenile drum and low numbers of spot (a demersal fish species) in the postrestoration collection in Brookley Hole, threadfin shad was the third most dominant species. Commercially important shellfish taken at both sites include both brown and white shrimp, eastern oyster, and blue crab. In terms of the entire fishery assemblages, white shrimp was the numerically dominant species captured in Brookley Hole and the second most abundant species captured at Airport Hole.

Conclusions regarding Brookley Hole. The partial restoration of Brookley Hole has shown a significant increase in benthic diversity and abundance although results are still subpar to the natural bay bottom. From an ecological perspective, the partial or complete filling of these dredged holes would benefit fishery resources through elimination of hypoxic/anoxic zones common to these bathymetric features. Complete filling would restore historical bathymetric contours to that area of upper Mobile Bay (Reine et al. 2014). Thus, Brookley Hole remains a suitable candidate for full restoration to its natural bathymetry at a future date.

Based on the overall benthic assemblage, either one or two conclusions can be made with regards to the present condition of Brookley Hole: 1) It has not fully recovered from postrestoration in terms of benthic assemblage, and/or 2) both dredged holes are still sufficiently deep relative to the natural Mobile Bay bottom and may never recover to a similar benthic condition found on the natural bottom without full restoration to the natural bottom bathymetry. Both holes remain candidates for further placement of dredged sediment for restoration to the natural Mobile Bay bathymetry.

Considering results of the postfill monitoring effort, the IWG recommended additional material be placed in Brookley Hole, with monitoring of sediment consolidation and water quality. SAM estimated that the hole has capacity for approximately another 750,000 yd^3. Once placed, material will consolidate, possibly creating capacity for additional material. The results of the next placement cycle along with the monitoring will determine future actions. The IWG also recommended SAM pursue use of dredged material to fill Airport Hole.

THIN-LAYER PLACEMENT (TLP) WITHIN MOBILE BAY: This disposal alternative involves the use of historical open-water disposal areas within Mobile Bay that were used prior to 1986 for maintenance of the Mobile Bay channel and implemented during emergency operations after Hurricanes Georges and Katrina. Utilizing these areas would allow the use of pipeline dredging equipment for thin-layer, open-water disposal on adjacent Mobile Bay bottoms (both east and west sides of channel) for the upper and lower Mobile Bay channel sections. These areas range from approximately –6 ft to –10 ft mean lower low water (MLLW), with placement to be conducted as thinly as possible but not to exceed 12 in. thickness (USACE 2013b).

A major concern of the resource agencies and the IWG regarding this disposal alternative has been not knowing how the material behaves once placed in the open-water areas. The concern is that the sediment could become remobilized and transported throughout Mobile Bay, where it could have an undesirable impact on existing ecological resources.

SAM requested ERDC in 2012 to perform a numerical modeling study to assess the dispersion of dredged material placed in thin layers within Mobile Bay near the federal navigation channel resulting from the 2012 emergency action (Gailani et al. in preparation). The specific goal of the study was to estimate 1) the short- and long-term fate of material placed in Mobile Bay, including transport to sediment-starved areas, and 2) reintroduction of dredged material into the navigation channel. The study was conducted as a multidisciplinary approach requiring model development for waves, hydrodynamics, and sediment transport in the Bay, as well as sediment properties and processes data collection. While this study by Gailani describes only one placement scenario (near-channel), the model represents transport throughout Mobile Bay and can be used in the future to evaluate multiple dredged material management options. Specifically, the following scenarios were simulated for TLP deposits at the designated placement sites within Mobile Bay: 1) a 4-month typical period, 2) Hurricane Gustav (2008), and 3) Hurricane Ida (2009).

Sediment transport Conceptual Site Model for Mobile Bay (CSM-MB). The hydrodynamic model Curvilinear Hydrodynamics in 3-Dimensions (CH3D) was incorporated into a sediment dispersion model Long-Term FATE (LTFATE) of deposited dredged material, with the appropriate grid and boundary conditions for development of the sediment transport CSM-MB. The site-evaluation tool LTFATE estimates the dispersion characteristics of a dredged material placement site over long periods of time, ranging from days for storm events to a year or more for ambient conditions (Scheffner et al. 1995). Simulations were based on the use of site-specific native and dredged material characteristics and local wave and current condition input. Results from the model CSM-MB indicated that approximately 35% of the sediment that erodes from the designated disposal areas is transported to and deposited in the navigation channel. The remaining 65% is widely dispersed throughout the bay by wind-, river-, and tide-driven currents.

Field data collection and analysis. ERDC collected sediment cores at the seabed from 11 sites throughout Mobile Bay in January 2013. Six sites were located in the northern section of Mobile Bay, and five sites were located farther south between Gaillard Island and Weeks Bay (Figure 1). No sites were located south of Weeks Bay. The lengths of the cores ranged from 10 to 30 centimeters (cm). Cores from the southern sites were predominately fine grained while those from the north were a mixture of sand and fine-grained sediment. Thus, the bed grain size

distribution is concluded to be vertically stratified in north Mobile Bay while the grain size distribution in the south is more consistent with depth.

Tidal and wave climate forces. The physics-based hydrodynamic circulation model ADvanced CIRCulation (ADCIRC) supplied model-generated currents and water-surface elevations to the LTFATE component of CSM-MB. ADCIRC is capable of simulating tidal circulation and storm-surge propagation over very large computational domains while simultaneously providing high resolution in areas of complex shoreline configuration and bathymetry (Luettich et al. 1992). The Mobile Bay ADCIRC mesh model domain encompasses the entire Gulf of Mexico and the western extent of the Caribbean Sea. The mesh consists of 153,330 nodes and 293,960 elements. The calibrated ADCIRC model was applied for a 5-month time period.

The numerical nearshore spectral wave model STeady WAVE (STWAVE) was used to develop wave characteristics throughout Mobile Bay. STWAVE is a finite-difference, phase-averaged spectral wave model based on the wave action balance equation (Smith et al. 1999, 2001). STWAVE simulates depth-induced wave refraction and shoaling, current-induced refraction and shoaling, depth- and steepness-limited wave breaking, wind-wave generation, wave-wave interaction, and whitecapping. The modeling events included long-term local conditions (1 February 2010–June 2010) and two storms, Hurricane Gustav (2008) and Hurricane Ida (2009).

Local conditions within Mobile Bay were simulated from 1 February 2010–1 June 2010 at 3-hour (hr) time-steps. The maximum significant wave height during the long-term local conditions simulation was 4.2 ft (1.28 meters (m)). The navigation channel and Gaillard Island within Mobile Bay are both shown to affect the wave climate as the largest waves in the area bounded by the channel and behind Gaillard Island were considerably smaller than the surrounding wave heights at approximately 2.0 ft (0.6 m) and 3.9 ft (1.2 m), respectively (Figure 3). (Contours are bathymetry referenced to mean tide line.) Hurricane Ida was modeled from 15 October 2009–December 2009 at 30-minute (min) time-steps. STWAVE was run at 30 min time-steps from 1 August 2008–1 October 2008 for Hurricane Gustav.

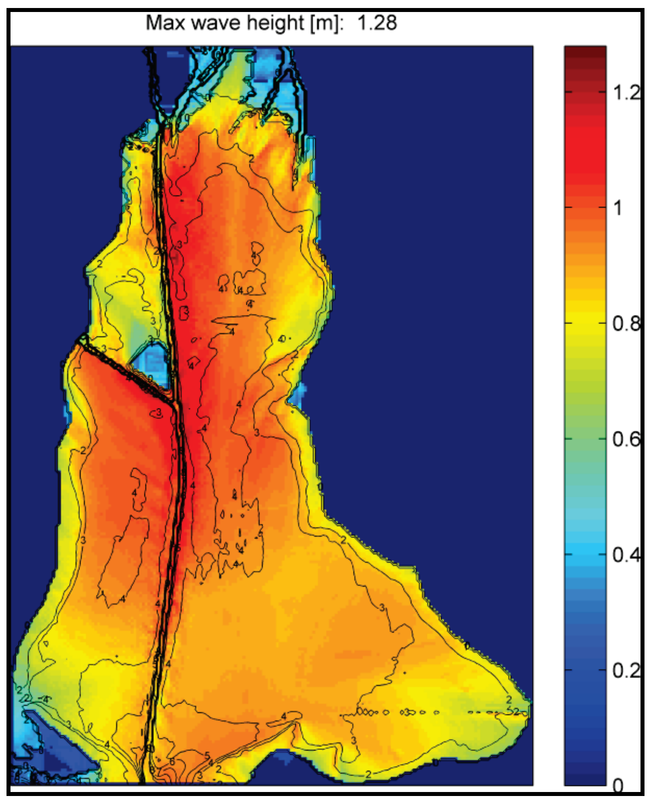

Figure 3. Wave height (m) for long-term local conditions, showing sheltering behind Gaillard Island. Contours are bathymetry referenced to mean tide line (m) vertical datum.

Bay sample laboratory erosion experiments. Mobile Bay navigation channel infilling is caused in part by resuspension of Mobile Bay sediments, some of which deposit in the channel.

Mobile Bay covers approximately 400 square miles and is shallow, typically 10 to 13 ft of water depth. Therefore, wind-driven currents and waves of Mobile Bay can resuspend bottom sediments if the critical shear stress is exceeded. Erosion data for native Mobile Bay sediments were collected for two purposes. First, the data supported development of both the preliminary and refined CSM-MB. Second, the data were used to parameterize the numerical model for sediment transport.

The purpose of this analysis was to determine the influence of local resuspension on infilling and TLP in north Mobile Bay. These experiments indicated that surface sediments in Mobile Bay eroded at approximately 0.4 Pascals (Pa). For the purpose of developing CSM-MB, these data indicate that the surface layers throughout the study area are susceptible to frequent resuspension and movement while sediments buried underneath these surface sediments are disturbed only during extreme events (hurricanes).

Mobile Bay native bed erosion versus TLP erosion. LTFATE was applied to identify transport patterns in Mobile Bay as a function of natural forcings, including river discharge, tidal flows, local wind driven currents, waves, and storm surge. The model was also applied to quantify change in transport patterns produced by dredged material TLP in Mobile Bay. Sediment transport modeling by Gailani et al. (in preparation) indicates the following impacts on the sediment transport patterns induced by TLP placement in Mobile Bay:

- TLP material does not significantly change bathymetric relief in Mobile Bay.
- TLP sediments are either similar to native sediment erosion potential or more erosion resistant than native sediment, particularly in the northern third of Mobile Bay.
- TLP materials can act as a shield, hindering mobilization of underlying native sediment.
- Comparison of native bed and TLP sediment transport modeling scenarios indicate that TLP does not significantly influence channel infilling.
- Comparison of native bed and TLP sediment transport modeling scenarios indicate that TLP does not significantly influence total suspended sediments near resources in Mobile Bay.

Conclusions regarding TLP within Mobile Bay. LTFATE modeling by Gailani et al. (in preparation) indicates that thin-layer sediment placement in Mobile Bay will have negligible impact on navigation channel infilling, total suspended sediments, and Mobile Bay bottom morphology. Sediment introduced by TLP will only contribute modestly to these processes.

As a result of the TLP monitoring and modeling efforts, the IWG concluded that a long-term option for conducting within-bay, thin-layer disposal should be pursued. Subsequently, SAM requested and was granted a permit modification to the federally authorized MHNP to change the TLP activity within Mobile Bay from being strictly an emergency storm-related action to also include a long-term, option for placement within Mobile Bay. Providing this option adds an environmentally acceptable alternative for managing dredged material from the Mobile Bay navigation channel. This option allows sufficient time for benthic recovery and permits the

bottom elevations to return to that of the adjacent bottom as the placed sediment is remobilized into Mobile Bay's natural sediment system.

UPPER BAY EMERGENT TIDAL MARSH: The third sediment management strategy introduced by the IWG in 2011 involves the development of a BU area in the upper portion of Mobile Bay to be used as a long-term placement area for material dredged from the Mobile Bay channel. The BU area will demonstrate beneficial use of such material to achieve environmental restoration utilizing semicontainment methods. The proposed final outcome of the BU region is the creation of a functional emergent tidal marsh. Such a project must be consistent with environmental standards established by the Section 404(b)(1) evaluation process which mandates demonstration that the material requires no physical, biological, or chemical testing. Key elements of this strategy emphasize connection between major maintenance dredging requirements of the Mobile Bay channel, beneficial uses, and regional sediment management methods that reduce dredging costs.

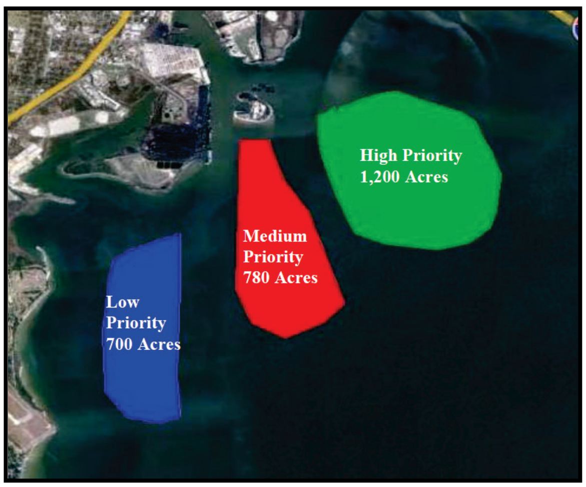

Figure 4. Potential Beneficial Use sites as prioritized by the IWG, April 2012.

Potential BU emergent tidal marsh locations. At an April 2012 meeting, the IWG (USACE 2012b) identified three potential BU locations within upper Mobile Bay that merited further investigation (Figure 4). The site assigned the highest priority by the IWG is the eastern-most site (green) due to its distance from Brookley airfield and possibly lower occurrence of cultural resources. This site is estimated to be 1,200 acres. Because of the depth and hydrodynamic conditions, a medium priority was assigned to the middle area (red) estimated to be 780 acres. The western-most site (blue), estimated to be 700 acres, was assigned the lowest priority due to airport restrictions and proximity to existing oyster beds. To finalize the BU site location and proceed to a design, additional information will be required such as cultural resources, SAV surveys, bird usage, benthic surveys, hydrodynamic/hydraulic modeling, geotechnical investigations, and bathymetric surveys. A determination was made from SAV surveys conducted by the Alabama Department of Conservation and Natural Resources, State Lands Division; the U.S. Fish and Wildlife Service; the National Oceanic and Atmospheric Administration; and SAM that no SAVs are likely to occur within the proposed BU site. Bathymetric surveys were completed by SAM in October 2012.

Cultural and archaeological study of potential BU emergent tidal marsh locations. The Alabama State Port Authority funded Southeast Archaeological Research, Inc. (SEARCH) (2013) to conduct a Phase I maritime archaeological investigation, including archival research and marine remote-sensing surveys, in upper Mobile Bay in preparation for the proposed creation of a BU emergent tidal marsh. The Phase I marine remote sensing followed Alabama guidelines including the use of magnetometers, fathometers, side-scan sonar, differential global positioning system, and line spacing of 50 ft. A total of 2,531 acres was surveyed.

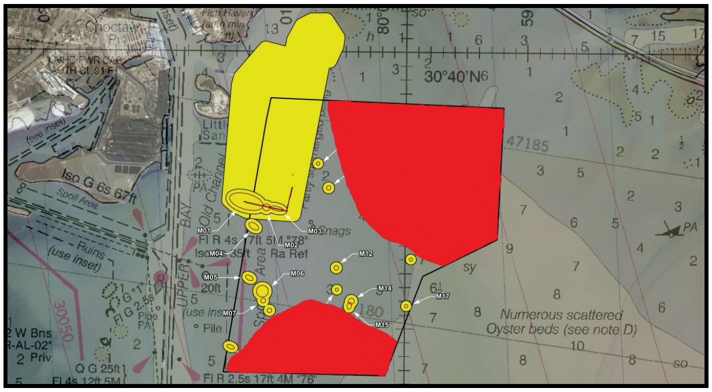

Figure 5. Upper Mobile Bay Beneficial Use emergent wetlands acceptable placement areas in red, and avoidance areas in yellow.

SEARCH maritime archaeologists documented numerous navigation obstructions within the area of potential effect (APE) that had been placed in upper Mobile Bay during the American Civil War. These obstructions consist of shipwrecks, bricks, and wood pilings. SEARCH also identified 14 magnetic anomalies within the APE as potential submerged cultural resources. SEARCH recommends avoidance of the Civil War obstructions by a distance of 328 ft and avoidance of the 14 anomalies by a distance of 164 ft unless their sources are identified. Figure 5 shows the generally rectangular-shaped placement area delineated by black boundaries, which is the preferred area selected by SAM in coordination with the IWG. Yellow indicates the avoidance areas due to the cultural and archaeological findings. Acceptable BU emergent tidal marsh areas are indicated in red.

At the March 2014 IWG meeting, discussions pertained to the next steps in developing the BU site. In light of the cultural resources survey, the IWG determined that additional investigations would not be necessary as the cleared area should provide sufficient acreage to create the BU project. Figure 6 shows the area that has been deemed clear of historical resources (USACE 2014). If more acreage is needed, additional surveys could be conducted on the targets within the blue area indicated in Figure 6.

Details of the cultural and archaeological survey of upper Mobile Bay by SEARCH (2013) are not included in this CHETN because locations of such information are exempt from the Freedom of Information Act (U.S. Congress (USC) 1966), per compliance with the National Historic Preservation Act (USC 1966b as amended through 2006). Based on results of the archeological survey, the IWG recommended proceeding with preliminary design with the first component being a geotechnical evaluation to identify the general substrate type and to help refine the BU site location.

Biodegradable structure for BU emergent tidal marsh. Recurring issues associated with this type of dredged material placement, particularly for fine-grained material, are the containment time within a placement site to allow for sediment consolidation and the physical confinement of the material to minimize potential environmental impacts. Containment of sediment for these types of applications typically requires some kind of berm or permanent structure that may itself result in undesirable impacts to the local hydrodynamics and environmental resources. The use of a short-term biodegradable containment structure may help alleviate this problem while allowing adequate time for the site to become established. A demonstration project to create/restore approximately 20 acres of tidal marsh is being considered along the northwestern leg of Gaillard Island (USACE 2013).

Aligned with the proposed 20-acre demonstration site was an RSM initiative to construct a second demonstration project to evaluate the use of a suitable short-term biodegradable structure for the 20-acre site and for other shallow-water restoration applications. This RSM

demonstration project, completed in 2013, was conducted on the southwestern corner of Gaillard Island in an area where the shoreline had been eroding. This demonstration covered approximately 4.0 acres and was approximately 1,500 ft long.

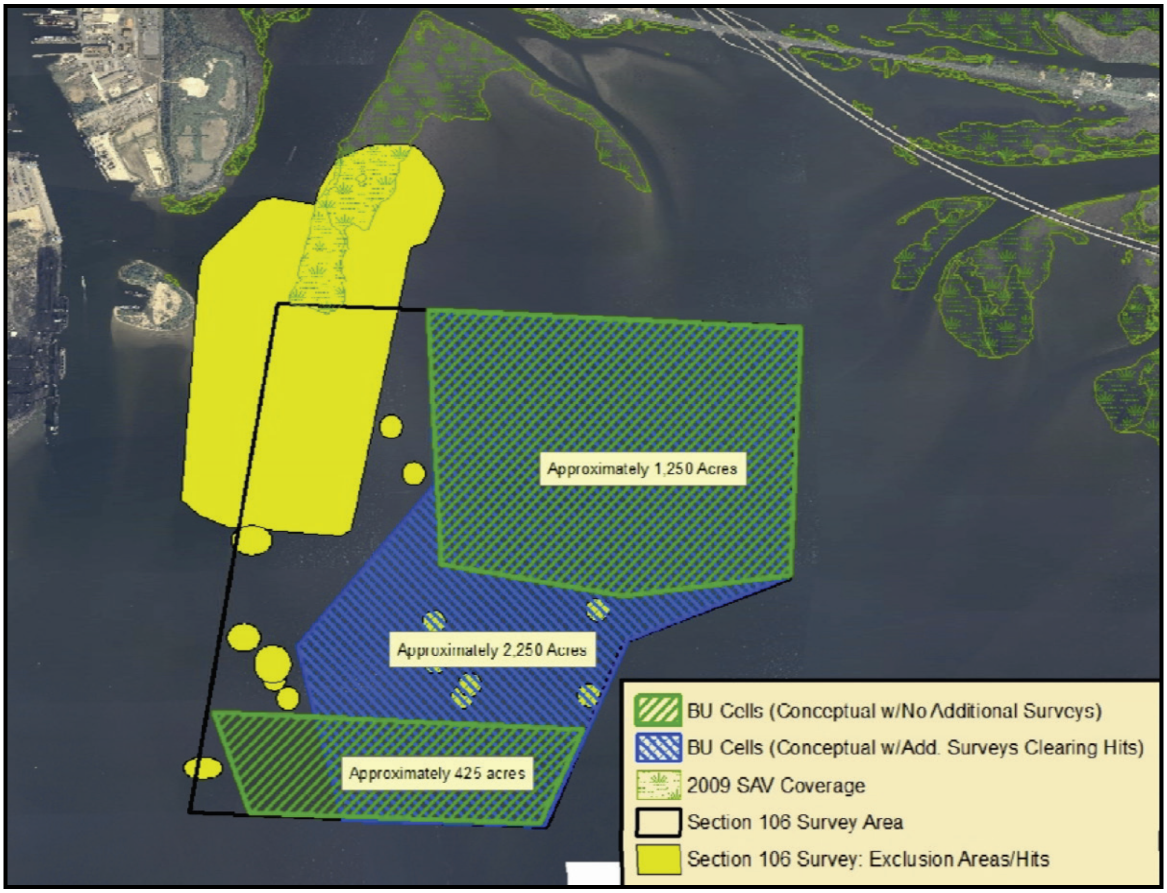

Figure 6. 1,250-acre area deemed by IWG to be clear of historical resources; meets criteria to create a BU emergent tidal marsh (USACE 2014).

This demonstration successfully tested several biodegradable containment options for managing sandy and fine-grain dredge material for BU projects. The 3-week Gaillard Island test project was one of the first in the United States to be constructed of 100% natural biodegradable products. The project tested and documented the performance of jute burlap silt curtains, antiscour aprons, and geotextile tubes, as well as a hay-bale weir. This demonstration project generated information sufficient to facilitate design of burlap tubes for varied sediment types, structure heights, and wave conditions. The materials used and the construction methods were appropriate (Lovelace, in preparation).

CONTINUED PLACEMENT IN THE ODMDS. By reducing the amount of sediment placed in the ODMDS through either long-term TLP, creation of an emergent tidal marsh, or beneficially using dredged material to fill man-made holes, more of the Mobile Bay sediment will be retained in the natural Mobile Bay sediment transport system. Both hydraulic cutterhead dredges and hopper dredges have advantages and disadvantages relating to Mobile Bay placement techniques.

Hydraulic cutterhead dredges are extremely efficient when clearing the entire template with a pumping distance up to 4 miles.

Hopper dredges are most efficient at removing heavy toe shoaling that extends over several thousand feet of the channel located in the lower end of Mobile Bay. Hopper dredges offer quick response times and needed flexibility to give immediate attention to critical shoaling over the entire footprint of the project. This flexibility can cost as much as \$6 to \$7/yd^3 in the upper end of the project due to the inability to efficiently over flow the fine-grained sediment and because of the long haul distances. Historically, Mobile Bay shoaling rates cannot be met using only hopper dredges. Typically, a cutterhead dredge needs to dredge all the available advanced maintenance material for the hopper dredges to successfully work the toe shoaling.

To capitalize on the efficiencies of both cutterhead and hopper dredges, the MHNP needs the flexibility to include both placement by hydraulic cutterhead dredge within Mobile Bay and/or placement in the ODMDS by hopper dredge when required. Placement within Mobile Bay may consist of open-water TLP adjacent to the channel, placement in an upper Mobile Bay emergent tidal marsh, and/or filling man-made holes. Having these placement options available will foster a more competitive bidding process between the two types of dredges and provide SAM better scheduling and budget options. Having these disposal options provides valuable environmental benefits consistent with RSM/EWN principles.

ADDITIONAL INFORMATION: The USACE EWN philosophy is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative processes. EWN can work synergistically with RSM to create new ways of conducting business and expanding the benefits of USACE projects which strategically place sediment for beneficial purposes. The elements of EWN are to 1) use science and engineering to produce operational efficiencies supporting sustainable delivery of project benefits, 2) use natural processes to maximum benefit, thereby reducing demands on limited resources, minimizing the environmental footprint of projects, and enhancing the quality of project benefits, 3) broaden and extend the base of benefits provided by projects to include substantiated economic, environmental, and social benefits, and 4) use science–based, collaborative processes to organize and focus interests, stakeholders, and partners to reduce social friction, resistance, and project delays while producing more broadly acceptable projects.

This Coastal and Hydraulics Engineering Technical Note (CHETN) was prepared by Larry Parson (*Larry.E.Parson@usace.army.mil*), Nathan Lovelace (*Nathan.D.Lovelace@usace.army.mil*), and Elizabeth Godsey (*Elizabeth.S.Godsey@usace.army.mil*), USACE SAM; Kevin Reine (*Kevin.J.Reine@usace.army.mil*), ERDC, Environmental Laboratory, Vicksburg, MS; and Dr. Joseph Gailani (*Joe.Z.Gailani@usace.army.mil*), ERDC, Coastal and Hydraulics Laboratory (CHL), Vicksburg, MS. Questions pertaining to the RSM strategy for Mobile Bay can be addressed to Larry Parson, Nathan Lovelace, or Elizabeth Godsey. Inquiries pertaining to Brookley Hole may be directed to Kevin Reine. Further information regarding thin-layer placement in Mobile Bay can be obtained from Dr. Joseph Gailani. Additional information pertaining to the USACE RSM Program may be found at the RSM web site *http://rsm.usace.army.mil* or by contacting the USACE RSM Program Manager, Linda Lillycrop (*Linda.S.Lillycrop@usace.army.mil*). Funding for preparation of this CHETN was provided by the USACE Dredging

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